



THE PROBLEM WITH COAL

Coal is the easiest fossil fuel to burn badly and the hardest to burn well:

But it can be done !

Sources of the problem:

The nature of the Fuel, originating from a mixture of Organics from the trees, and Inorganics from the soil that the trees were growing in.

It is a solid so that =>

- *It pyrolyses in the flame, forming volatiles and char so that the volatiles initially screen the char from oxygen attack and allows time for the char to anneal and fall in reactivity. This increases the combustion time and the chamber size needed for combustion efficiency*
- *The organic fraction (from the trees) contains nitrogen and some of the sulfur, and these form NOX and SOX*
- *The inorganic fraction (the soil mineral matter) transforms in a flame to ash that sometimes can melt in the furnace, the source of "slagging and fouling" that increases maintenance and (annual) repair costs. In some coals there is also inorganic sulfur that is the source of further SOX*
- *The NOX, SOX, and "ROX" (particulates) must be reduced to meet environmental standards, and that can be a heavy cost*
- *Poor design and/or operation of the firing system can result in smoke production, particularly from solid bed (grate) firing*
- *As commonly used, coal is less adaptable to combined firing (gas-turbines/boilers) that otherwise can increase the output efficiency.*

What Are Some Of The POSSIBLE SOLUTIONS?

• **Efficient Burn-Out**

Burn the coal at high intensity.

It heats 10 times faster;

does not have time to anneal;

and burns out in 1/10th of the time

• **Slagging, Fouling, and Particulate Control**

Deep-clean the coal to form a coal-water-fuel (CWF) with < 1% mineral matter, and fire as a liquid slurry. Reduction of the mineral-matter reduces or eliminates slagging and fouling, and minimizes particulate control.

• **Smoke Control in Solid Bed (Grate) Firing**

Optimize the over-to-underfire air to maximize the fuel supply (volatiles and "smoke") going to overbed combustion, and configure the overbed mixing to the "Bragg (Rolls Royce) PSR/PFR Criterion"



Smoke

SMOKE is a Fuel

To remove it: Burn it. This requires:

- **A minimum concentration (above the LL)**
- **A PSR/PFR Mixing configuration**

Biswas, & Essenhigh: Some Characteristics of Stabilized Smoke Flames. Combustion & Flame, 15: 93-96 (1970)



Smoke Flame